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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

OUTBOARD
MOTORS
Care and Lubrication

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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OUTBOARD MOTORS

Care and Lubrication

HOW OFTEN it is the small things that have a profound influence on future events. For lack of a dish of ice cream the present day fisherman and camper is able to relax in his boat and let an outboard motor propel him to his destination.

The story is that Ole Evinrude, a young Milwaukee machinist, had to row across a lake and back to fulfill the desire of his fiance for some ice cream. Upon his return (with a somewhat soggy package), there was in his mind a firm conviction that there should be a "better way." He applied his ingenuity to his problem, and in 1910 he patented the forerunner of the present day outboard motor. How well he designed his motor is evidenced by the fact that the modern outboard motor has changed comparatively little. There have been, to be sure, increases both in the number of cylinders and the amount of power which outboards are capable of delivering, and mechanical refinements in bearings and metals that make the light weight models now available a huge improvement over the original. But even the multi-cylinder descendant accepted so casually today still shows the characteristics of the original.

It might be well to mention that although outboards are the principal topic of discussion, there are many other applications where the 2-cycle engine has answered an important need. This would include their use as a power source for electric generators, water pumps, blowers, lawn mowers, chain saws, etc. The operation and lubrication of the engine remains the same although changes in design may be indicated due to certain limitations not encountered with the outboard. Also, due to the fact that cooling water is often not readily available, these "shore" engines rely more often on air cooling. The power output is generally small, usually having a maximum of 10 horsepower.

4-CYCLE OPERATION

Outboards employing the 4 stroke cycle are available, although they are much less common than those employing the 2 stroke cycle. The 4 stroke cycle engine operates exactly like the engine in an automobile and requires two complete revolutions of the engine crankshaft to complete the full cycle. On the first upward movement of the piston, the fuel mixture is compressed and at the proper instant the spark plug fires. The power derived from combustion of the air-fuel mixture is imparted to the piston to force it down for the completion of one revolution. The exhaust gases in conjunction with proper valve timing are forced out of the combustion chamber on the next upward movement of the piston and on the next downward movement the new fuel charge is admitted to the combustion chamber. This new charge is compressed, fired, and exhausted as the cycle repeats. The 4 stroke cycle engine is splash lubricated by the oil in the crankcase, and as in the automobile the quantity and quality must be checked and the oil changed at regular intervals, 25 hours being a normal drain period in outboard service.

2-CYCLE OPERATION

There are several important differences between the operation of the 4 stroke cycle outboard and the 2 stroke cycle outboard motor. The 2 stroke cycle engines, usually referred to as "two-cycle" for

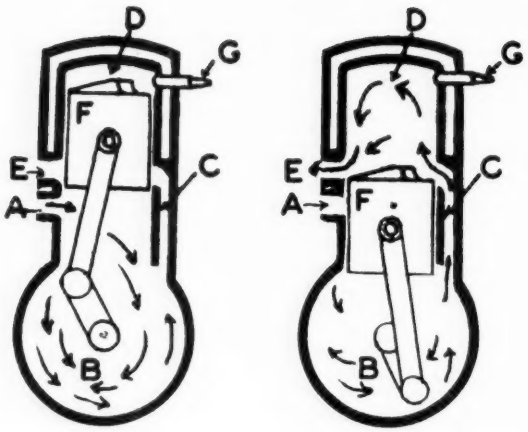


Figure 1 — Showing 2-cycle engine 3 port system. A — intake port, B — crankcase, C — by pass port, D — combustion chamber, E — exhaust port, F — piston, G — spark plug.

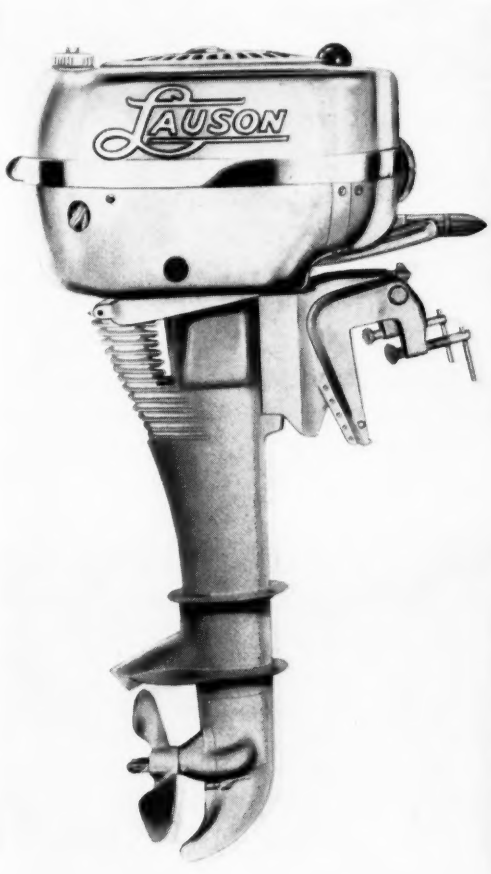
simplicity, turn over at more revolutions per minute, usually 3500 to 5000, fire on every revolution and are lubricated by the oil which is mixed with and carried by the fuel. By utilizing these differences the designer has simplified the design so that the valves of the 4 stroke cycle engine have been eliminated, the ignition system has been made more compact and lubrication has been accomplished without a complicated lubricating system employing a pump and reservoir.

The overall saving in moving parts, by elimination of lubricating systems, and by increasing the number of power strokes per revolution, produce a power unit of light weight and simple design that has been extremely useful both commercially and for the sportsman. As the same problems of admitting the fuel and exhausting the burned gases must be accomplished in one complete revolution of the crankshaft, a different method of approach must be used in these engines. This objective is attained by using the movement of the piston in conjunction with a suitably arranged system of ports in the cylinder walls. A study of the diagram outlines the manner in which the arrangement of ports permits the cycle to be utilized. See Fig. 1.

The upward movement of the piston (compression strokes) first closes by-pass port "C", then after a very short interval exhaust port "E". The continued upward movement of the piston compresses the fuel, air and oil mixture in cylinder "D". Near the top of the stroke a partial vacuum has been established in the crankcase and as the intake port "A" is uncovered the fuel flows and is drawn into the crankcase from the carburetor. After firing, the piston is forced down (power stroke) closing intake port "A" and the mixture now in the crankcase is compressed due to the further downward movement of the piston. Exhaust port "E" is opened near the end of the strokes to vent the spent gases, and by-pass port "C" is opened to admit a new charge. The compressed fuel mixture in the crankcase, entering the cylinder for the next revolution, also aids in sweeping out the combustion chamber and a new cycle is started.

The use of ports as described above is but one way of controlling the fuel mixture charge to the crankcase. It may be admitted through the crankshaft using its rotation as a means of valving the fuel mixture, through a leaf spring valve actuated by the pressure differential in the crankcase, by a rotating disc, or by poppet valves controlled by crankshaft cams. See figures 3 and 4 for two of these alternate methods.

The amount of the oil to be mixed with the gasoline varies somewhat from one make of engine to another generally being ½ to ¾ of a pint of oil per gallon of gasoline for normal usage. The amount may also vary depending on the type of service in which the motor is to be employed –



Courtesy of The Lauson Company

Figure 2 — Exterior view of Lauson 4-cycle outboard motor.

less oil being required for light work, such as trolling, to double or triple the amount of a heavier grade oil for heavy duty, such as racing. The factors affecting the choice of an oil will be covered more fully later in this article.

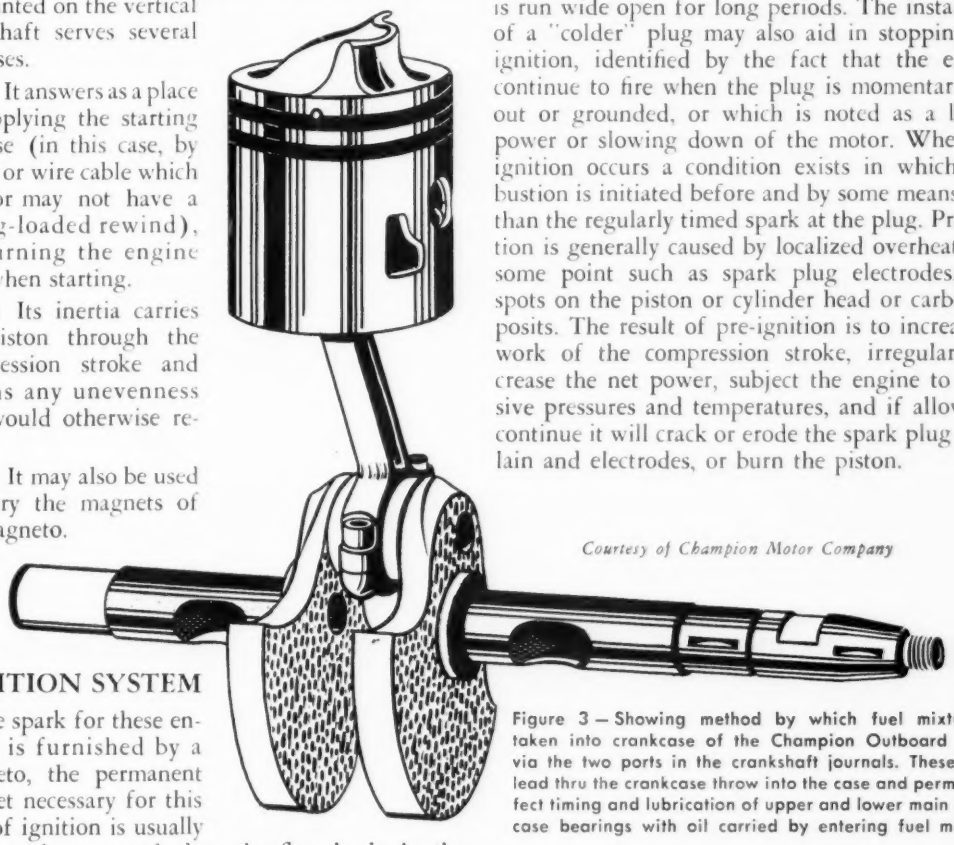
There is a wide variation in the size and power developed by these engines ranging from 1¼ to 50 horsepower, that enables them to be of service to the sportsman as well as answering the needs of those engaged in commercial enterprises. During the recent war, this variation of power available proved enormously useful to the armed forces in the propulsion of various sizes of craft.

The fly wheel at the top of the outboard which is mounted on the vertical crankshaft serves several purposes.

(a) It answers as a place for applying the starting impulse (in this case, by a rope or wire cable which may or may not have a spring-loaded rewind), for turning the engine over when starting.

(b) Its inertia carries the piston through the compression stroke and lessens any unevenness that would otherwise result.

(c) It may also be used to carry the magnets of the magneto.



Courtesy of Champion Motor Company

Figure 3 — Showing method by which fuel mixture is taken into crankcase of the Champion Outboard Motor via the two ports in the crankshaft journals. These ports lead thru the crankcase throw into the case and permit perfect timing and lubrication of upper and lower main crankcase bearings with oil carried by entering fuel mixture.

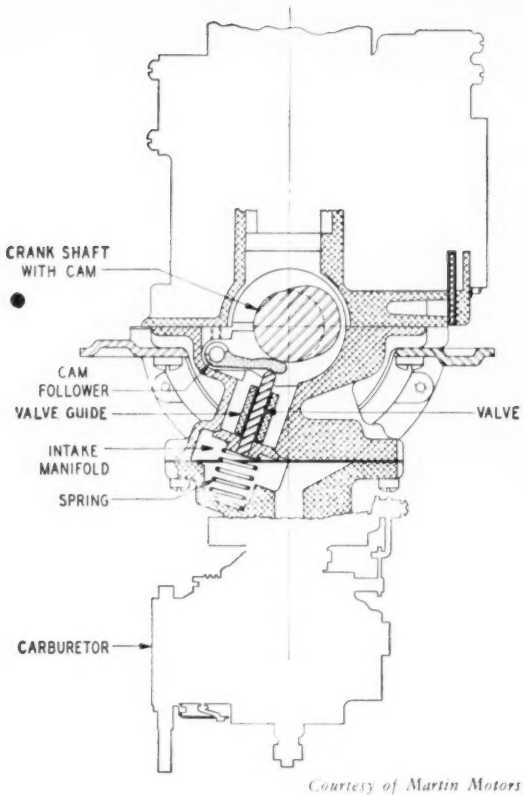
IGNITION SYSTEM

The spark for these engines is furnished by a magneto, the permanent magnet necessary for this type of ignition is usually but not always attached to the fly wheel. As the crankshaft and flywheel rotate the poles of the magnet pass the core poles of the ignition coil and set up an induced magnetic field in the coil. The electric current thus formed flows through the primary winding and across the breaker points building up a large magnetic field. When the breaker points separate the primary current is interrupted and the collapsing magnetic field induces a high voltage current in the secondary winding (this secondary winding is made up of a large number of turns of fine wire which increases the voltage over that of the primary). The high voltage current induced in the secondary winding is carried to the spark plug where it produces a spark as the current jumps between the electrodes.

The satisfactory operation of outboard motors is dependent upon the satisfactory functioning of spark plugs and as might be imagined both the oil and the plug used may materially affect the results. There is a wide range of plugs from hot to cold that enables the owner to find the one best suited to the conditions under which his own motor is operated. The plugs originally supplied by the manufacturer are generally the most satisfactory under normal operating conditions, but a "colder" plug may prove more advantageous, if the motor is run wide open for long periods. The installation of a "colder" plug may also aid in stopping pre-ignition, identified by the fact that the engines continue to fire when the plug is momentarily cut out or grounded, or which is noted as a loss of power or slowing down of the motor. When pre-ignition occurs a condition exists in which combustion is initiated before and by some means other than the regularly timed spark at the plug. Pre-ignition is generally caused by localized overheating at some point such as spark plug electrodes, high spots on the piston or cylinder head or carbon deposits. The result of pre-ignition is to increase the work of the compression stroke, irregularly decrease the net power, subject the engine to excessive pressures and temperatures, and if allowed to continue it will crack or erode the spark plug porcelain and electrodes, or burn the piston.

A plug that is too cold will cause hard starting and poor idling and may be identified when the plug is wet upon removal or fouled with a black gummy deposit. A "hotter" plug will tend to eliminate smoking and fouling that is sometimes encountered when trolling for long periods.

The spark plug manufacturers have been very conscious of the problems inherent in this type of engine and considerable work has been done and is still being done to extend the service life of the plug and to improve the performance of 2-cycle engines. Plugs are becoming available to a limited



Courtesy of Martin Motors

Figure 4 — Showing how poppet valve actuated by cam on crankshaft controls the entering fuel mixture in the Martin Outboard Motor.

extent which cost somewhat more initially but more than pay for themselves in length of service and efficiency.

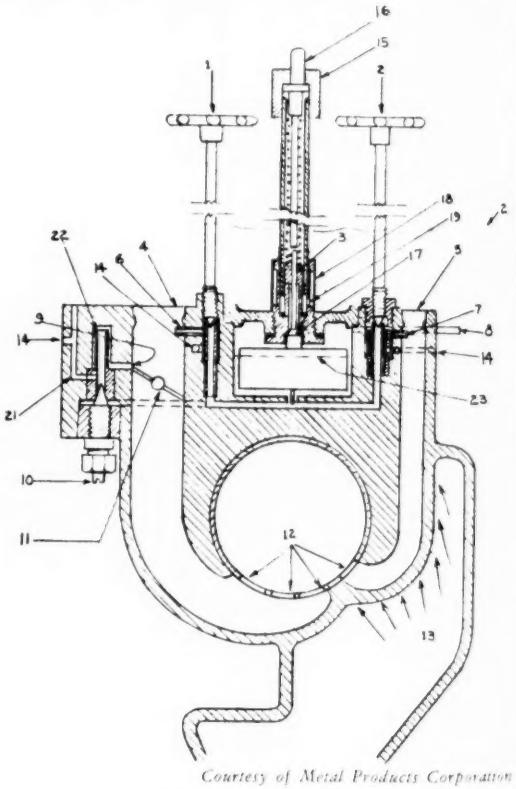
A bridged spark plug may be cleaned in an emergency by scraping the electrodes and resetting the gap to .025". Other types of fouling or plug failure do not respond to such simple methods and replacing the plug is generally a more satisfactory solution.

FUEL SYSTEM

The fuel system is not complicated in most outboards but the proper mixing of the fuel and lubricating oil cannot be overemphasized. It does not matter greatly whether the fuel is poured into the proper amount of oil in the mixing container or the reverse. Thorough mixing, however, is imperative. For most satisfactory results, mixing should be done in a separate container and the mixture then strained through a fine mesh screen into the fuel tank to remove water and dirt that otherwise might enter the tank and become a source of trouble. Improper mixing can lead to failure of the motor. If lubricating oil enters the system in too large amounts, the engine is hard to start, the exhaust is smoky and the plugs become fouled. If the fuel has too little oil the engine will start easily enough, but will shortly overheat due to metal to metal contact and increased friction causing the piston to score or seize and a ruined engine may result.

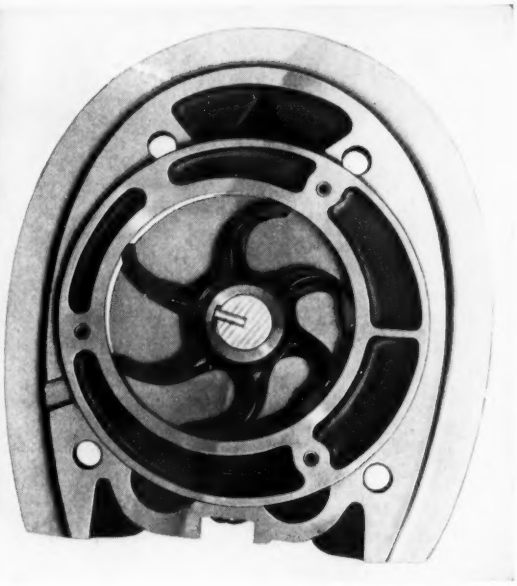
The sketch in Fig. 5 shows a carburetor designed by one manufacturer to obtain dual carburetion and satisfactory fuel flow under all conditions.

In some carburetors there is incomplete mixing when the velocity in the large manifold becomes too low and the gasoline vapors (in some cases liquid) tend to pocket or settle out of the fuel-air mixture. In the model shown, this is prevented by shutting off the high speed carburetor completely at low speeds and operating off of the small manifold and maintaining a high velocity. To further maintain good vaporization the low speed manifold is run through the exhaust manifold where it picks



Courtesy of Metal Products Corporation

Figure 5 — Sketch of carburetor designed for dual carburetion under various speed conditions as used in Flambeau Outboard Motor. 1) High speed adjustment. 2) Low speed adjustment. 4) High speed intake. 5) Low speed intake. 6) High speed gas jet. 7) Low speed gas jet. 8) Overflow from float bowl. 9) Intermediate gas jet. 10) Intermediate needle adjustment. 11) Butterfly valve. 12) Cylinder third ports. 13) Exhaust heat. 15) Gas shut off valve. 16) Priming pin. 21) Accelerating well. 22) Needle seat and standpipe. 23) Gasoline level.



Courtesy of Johnson Motors

Figure 6 — Water pump with rubber vanes used in Johnson outboard motors.

up heat. By having the dual carburetors the adjustment that would normally be for low speeds is not operable until reaching intermediate speeds and it thus becomes an intermediate speed adjustment. The essential difference with this system is that the carburetor does not load up (rich mixture) at low speeds, and an auxiliary supply of gasoline is provided for acceleration as is done in the usual automobile carburetor by the accelerating pump.

Acceleration is accomplished simply by using the U tube formed by the standpipe (22) and passage (21) while the throttle valve is closed. Gasoline passing the adjusting valve fills the U tube to float chamber case level (23). When the throttle is opened the contents of the U tube is emptied into the manifold through jet (9). This supplies the gasoline for the air passing the high speed jet (6) before the gas begins to come from this jet.

COOLING SYSTEM

Most outboards are water cooled and various methods of securing adequate circulation and cooling are employed satisfactorily. In one case, a scoop aft of the propeller takes in the water and forces it upward around the cylinders. In this method a vent in front of the propellers forms a modified vacuum and the combination of the two combines to complete the circulation throughout the system. In other cases a positive displacement pump or a centrifugal pump is attached to the driveshaft. These pumps force water through the cooling system and their longevity depends upon the conditions to which they are subjected. Operation under flood conditions where large amounts of silt are encountered is particularly hard on some pumps. The vanes of the pump may be made of either metal, composition or rubber. (See Fig. 6.) In almost all cases the flow of water is upward around the cylinder and out of the discharge which is located either in the exhaust or has separate piping.

One system is shown in Fig. 8. It should be noted that there are in effect two cooling systems, and the amount of coolant passing through the motor is controlled by the speed of operation. Water enters the gear housing at A, passes through a two-stage centrifugal pump and rises to the top of the pump housing. At B the water enters two holes in an extruded tube and rises to the power head. At C it passes each side of the lower journal bearing which is subjected to heat from the exhaust system and into the cylinder. Two tubes pass in parallel around the cylinder bores in opposite directions to insure most uniform heat distribution, and back into another extruded tube running downward. One tube empties into the atmosphere through an exhaust chamber at D. The other empties nearer the water line at E.

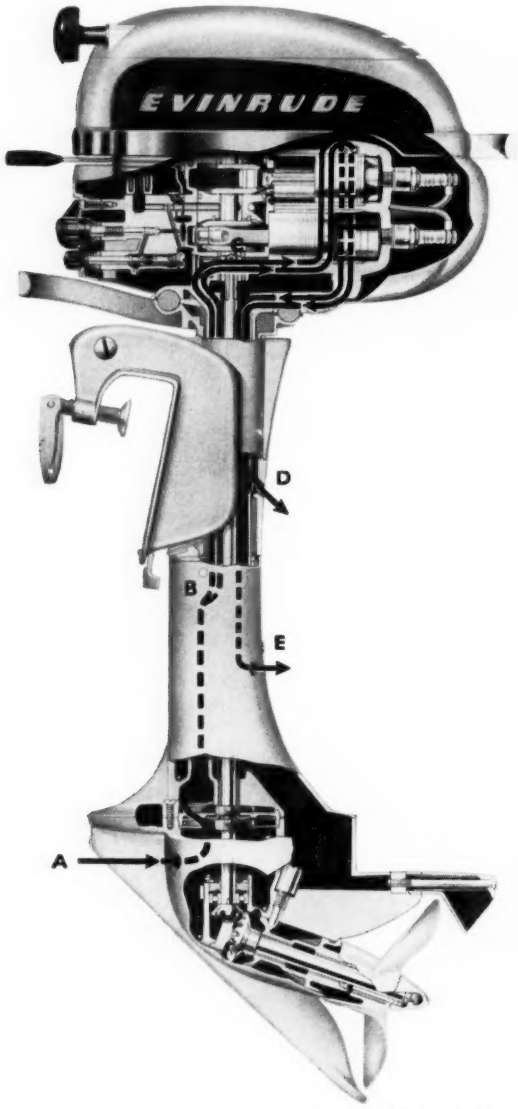
Both of these cooling circuits operate at high speed when the pump is working at maximum

Courtesy of West Bend Aluminum Company

Figure 7 — Exterior view of 6 H.P. De Luxe Elgin Outboard Motor.

pressure. At approximately 700 rpm the pump head drops to a point where the circuit terminating at D loses its syphon. At D the exhaust gases are mixed with water which tends to silence them as they leave the port thus the loss of water at D provides greater exhaust relief for idling. It is advantageous to run the cylinder slightly hotter at idling speed and the loss of water in one tube raises the cylinder temperature.

The tube which continues to cool the motor at low speed, terminating at E continues to carry water even at very low idling speeds because it comprises an almost complete syphon circuit.



Courtesy of Evinrude Motors

Figure 8 — Some Evinrude Outboard Motors use a cooling system with dual tubing which furnishes varying amount of coolant for different operating conditions.

POWER TRANSMISSION AND CLUTCH

The power derived from the engine is transmitted from the vertical drive shaft, through a pinion gear mounted on the lower extremity to a bevel gear attached to the propeller shaft.

The propeller is mounted on the propeller shaft which is driven by the bevel gears mentioned above. In older models, the propeller is attached directly to the shaft by a pin of softer metal which can shear off when some underwater obstruction prevents the propeller from turning. Owners of this type of motor should always carry a supply of these pins with them when leaving shore. Later models, however, employ various means of providing for a slipping action which acts as a clutch to permit the engine to run while the propeller has stopped temporarily, without damage to either engine or propeller. Some have a rubber mounting collar which fits over the shear pin, with a metal hub on the shaft under the propeller hub. When the propeller is stopped the rubber collar rotates until the obstruction is removed or passed over whereupon the rubber reseats around the pin and again drives the propeller.

One manufacturer employs a multiple disc clutch consisting of composition plates, one set of which is keyed to the propeller shaft and the other set keyed to the propeller. This clutch is kept in engagement by the forward thrust of the propeller. Upon striking an object the propeller loses its forward thrust thereby disengaging the clutch, eliminating the necessity of a shear pin. By using the propeller thrust to engage the clutch, the torque required to slip the clutch varies with the thrust and speed of the propeller. See Figs. 9 and 10.

In this connection a word on shear pins is in order. These pins are designed and manufactured to carry the maximum (plus a safety factor) torque of the engine. They afford their protection in that they shear if the propeller is obstructed at maximum speeds, and the motor and propeller are not injured. At low speeds the quick shearing action is not obtained, and although the pin may eventually give, an additional strain has been put upon the engine and the propeller may become seriously damaged. It is the normal tendency to slow down when entering obstructed waters which is the opposite of the procedure which would be recommended by engineering practice. As strange as it seems, it is easier on the motor and propeller to operate at high engine speeds in obstructed water to take advantage of this shearing action.

SHIFTING MODELS

The innovation on the 1949 outboards is the use of a shift which gives the operator a choice of forward, reverse, or neutral and gives a flexibility

f operation that was not obtainable previously. The principle employed based on the fact that the reduction bevel gear on the drive shaft ntrols the direction of rotation of the propeller. In models prior to 949, some propellers turned clockwise and some counter-clockwise epending upon the contact position of the bevel gear, either forward aft of the pinion gear. These new models have merely taken advanage of this previously known fact and by installing two bevel gears so hat either one, or neither, is engaged with the propeller shaft until ositioned and linked by a dog clutch, the propeller can be driven in ither direction or allowed to remain idle.

This sliding member or dog clutch is mounted between the two bevel ears and is free to slide backward or forward on the shaft. The clutch nd propeller shaft have mating surfaces so that they must rotate toether. This clutch has extensions that meet with indentations in the ear hubs. In the neutral position the sliding member and bevel gears re not in contact and although the pinion on the driveshaft continues o drive the bevel gears the power is not transferred to the propeller haft. When the clutch is engaged with either of the gears, the transfer f power is from the driveshaft pinion to the bevel gear to the clutch o the propeller shaft, direction being determined by the gear that the

Courtesy of Metal Products Corporation →

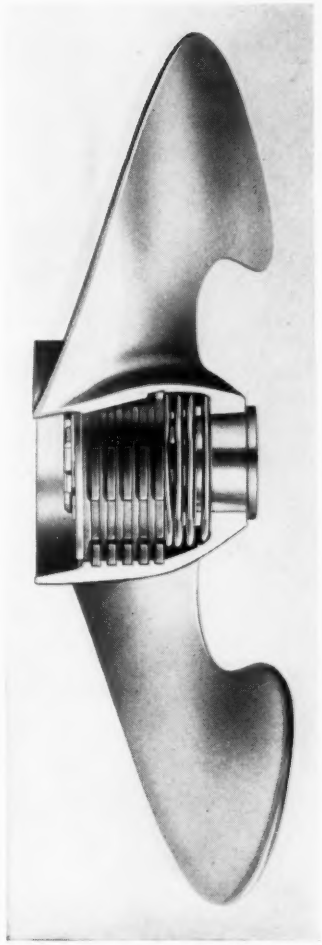
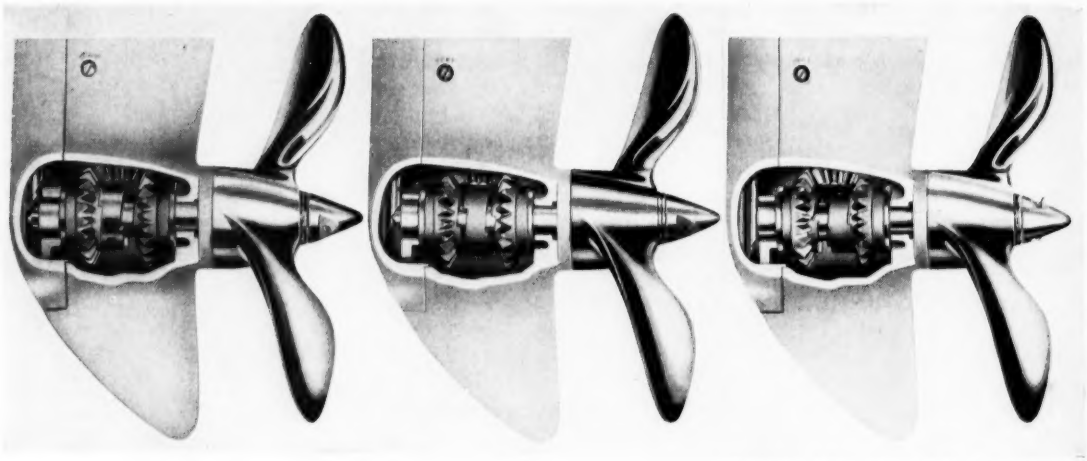


Figure 9 — Multiple disc clutch used on Flambeau Outboard Motor. Extensions which key discs to propeller may be seen in cut-away. Alternate discs are keyed to shaft.

Courtesy of Scott-Atwater Manufacturing Co.

Figure 10 — Clutches used on Scott-Atwater Outboard Motors. This clutch permits slipping action between clutch cone and clutch lining when propeller hits an obstruction. Parts from left to right are: adjusting bushing, spring washer, resilient washer, propeller, clutch lining, clutch cone.



Courtesy of Scott-Atwater Manufacturing Co.

Figure 11 — Showing position of dog clutch and operating cam for forward, neutral, and reverse reading from left to right as used in Scott-Atwater Outboard Motors.

clutch engages. Safety devices to regulate the speed at which shifts can be accomplished are incorporated to protect the motor against over-speeding in neutral and reverse. The inclusion of the additional gear and the levers to control the position of the dog clutch have not materially increased the weight of these motors. Lubrication of one of these units is accomplished by using an SAE 90 EP lubricant. The other continues to use the same special water-proof grease that is normally employed in the lower gear case. This grease will be discussed more fully later. See Figs 11 and 12.

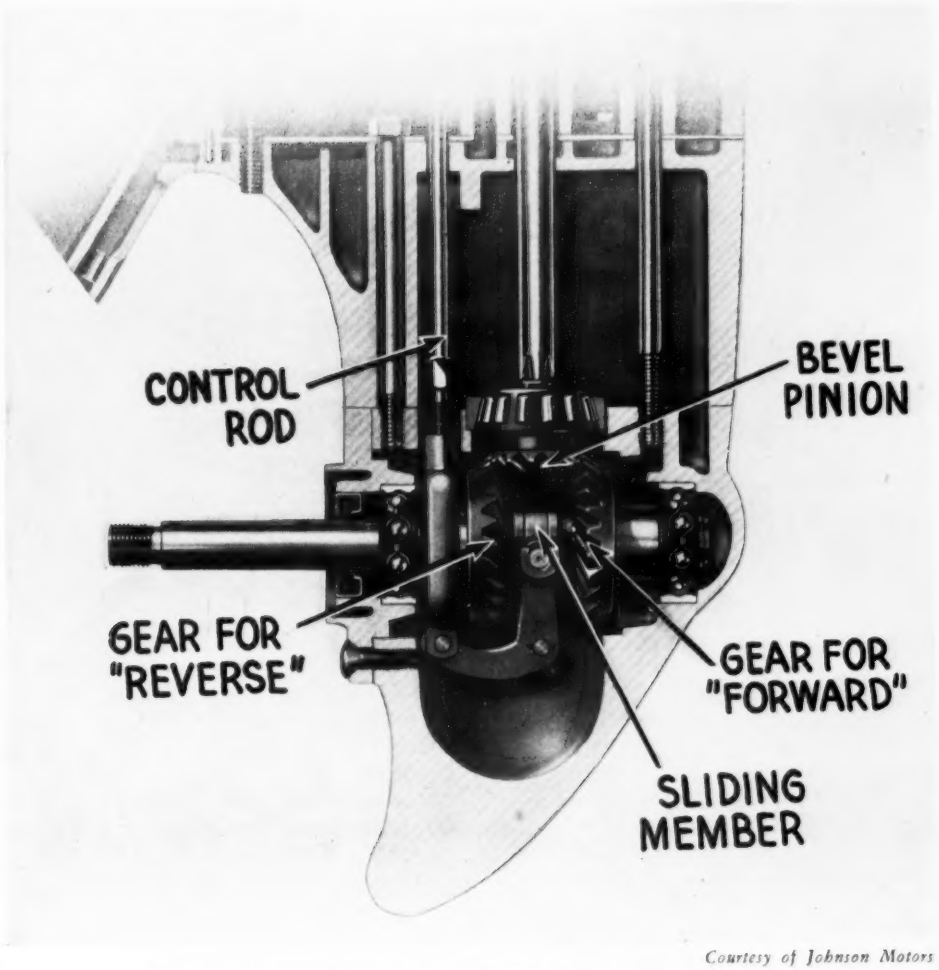
IMPORTANCE OF LUBRICATION

Outboard motors are subject to an extremely wide variety of performance requirements. The usual operator is the sportsman — or the water enthusiast who uses his motor for recreational purposes. For instance, a fisherman may drive his boat at top speed to the fishing grounds, then troll at extremely low engine speeds for hours following which, a return may be made at high speed. The owner with a fast hull may run his boat and engine at top speed for hours. Under all these widely varied service conditions of high or low speed and high or low power output — it is necessary to have a dependable lubricating oil which will provide superior performance, i.e., protect all moving parts from wear, produce little or no deposits, and contribute to economical and continued trouble-free operation.

Outboard motors, and other two-cycle engines of this type previously mentioned, are lubricated by the oil carried in the fuel. This oil must lubricate the main bearings, the piston walls, connecting rod bearings on both the crank and pin ends, and as these bearings may be either bronze or needle type a quality product is a necessity to obtain the performance that has been built into the motor. The exact form that the entering fuel mixture takes has not been definitely determined, although it is believed to be a finely atomized mixture in which the fuel component is largely vaporized while the oil is present in very small droplets which settle to form the lubricating film on the bearing surfaces.

For any one gasoline and oil-fuel mixture, an equilibrium is established within the crankcase and in the combustion chamber that determines the lubrication conditions under which the motor must operate. The oil carried by the fuel entering the crankcase forms the film upon which the bearings and pistons rely for lubrication. It is interesting to follow the flow of the fuel mixture through the motor in order to understand the way in which the oil performs. Upon entering the crankcase the oil forms a film on all interior surfaces to lubricate the engine. As flow of the fuel mixture continues, the excess over the lubrication needs will again be transformed into a mist of fine droplets by the movement of the engine parts. If this were not true, the excess of oil would accumulate in the crankcase. This mist is then carried continuously into the combustion chamber where it again forms a film upon all surfaces including spark plugs and piston heads as well as those points where lubrication is needed. This is confirmed by the fact that the piston and cylinder walls are wet with an oil film whenever the engine is stopped and inspected after it has been running on a satisfactory fuel and oil mixture. During the course of combustion, the oil will be burned along with the fuel.

The use of a proper oil obviously is very important, i.e., it should possess special characteristics which will enable it on the one hand to lubri-



Courtesy of Johnson Motors

Figure 12 — Showing members of gear case for operation of shift use in Johnson Model QD Outboard Motor.

cate satisfactorily, and on the other hand to reduce deposits in the combustion chamber to a minimum. Low deposit forming tendencies protect against ring sticking, port clogging and reduce ignition troubles.

Extensive studies of the effect of different base oils and additive type oils in outboard motors have resulted in the marketing of oils designated as being satisfactory for outboard motor use.

OIL SELECTION

The best reason for owners of outboard motors using an oil manufactured specifically for these motors is to insure that their engines are lubricated at all times with a motor oil of the most desirable characteristics. Aside from the small portion which may work its way through the bearings and along the shaft, all of the oil is subjected to high operating and combustion temperatures with the resulting oxidation and burning of the lubricant and the formation of some deposit on the piston and in the combustion chamber.

Paraffin base oils have a low volatility and will withstand higher operating and piston temperatures while retaining their lubricating value. Upon burning however they may leave a larger and more tenacious deposit and the products of combustion and oxidation formed by this type of oil in the combustion chamber, on the piston head, and cylinder side walls are sticky and tarry. These formations have great adherence to metal surfaces and they tend to clog the piston rings and varnish the pistons more readily than oils of higher volatility.

Varnish and sludge may also form in the crankcase on the connecting rods, connecting rod bearings, and wrist pins, and they are affected by extremes of temperature both high and low. Low water temperatures may lead to low operating tem-

Figure 13 – Metallic deposit fused across electrodes of spark plug.

peratures and deposits may accumulate throughout the engine. High engine temperatures promote the oxidation of the oil and the formation of varnishes as noted above, occasionally with serious results to the engine.

Naphthene base oils form small amounts of sooty types of deposit which do not adhere as readily to the metal and which blows out more easily through the exhaust, thus keeping the combustion chamber, piston and exhaust system fairly clean. Being more volatile, however, than paraffin base oils, they evaporate more readily from the pistons and cylinder walls and permit higher ring and cylinder wear, under full load, and in extreme cases of overloading or overspeeding may allow piston seizure due to metal to metal contact.

There are thus these two extremes that the refiner has to work between to produce the best lubricant. The ideal situation is attained somewhere between these two so that the finished oil gives the maximum lubricating protection with the least deposits. The wide choice of base stocks and modern refining methods enable the refiner and marketer to process and offer products so that the ultimate in performance is assured to the user. There are motor oils available in service stations that are satisfactory lubricants for use in outboard motors, although some of these oils would usually not be as satisfactory from the standpoint of deposit formation, ring sticking, port clogging, short spark plug life, etc.

ADDITIVE OILS

The use of additives to promote engine cleanliness and give better oil stability is effective in outboard 2 stroke cycle gasoline motors as well as in 2 stroke and 4 stroke cycle gasoline and diesel engines that are lubricated by the oil carried in the crankcase. Many tests conducted on outboard motors have demonstrated that the use of an additive oil improves engine cleanliness both in the crankcase and on the pistons when compared to the usual straight mineral oil.

Since the additives used for the promotion of cleanliness of engine parts usually are oil soluble complex compounds of metallic base, they in combination with the lead salts from the tetraethyl lead present in gasoline, if present in appreciable quantity, may give excessive deposits on the piston crown, inside the cylinder head and at the exhaust ports and frequent cleaning of the engine may be required. Also these metallic deposits will sometimes fuse across or bridge the spark gap. See Fig. 13 for a typical bridge. This results in misfiring and eventual engine stoppage.

Such deposits also may build up gradually between the spark plug electrodes and partially close the spark plug gap. When the gap is reduced in this manner, it will reduce the spark plug electrical resistance and the spark will occur in that particular cylinder as much as 50 degrees before the normal time. This premature spark known as a maverick spark does not occur with all types of magnetos.

During the war some initial difficulty was experienced with large horsepower engines which resulted in piston failure using additive oils available for the armed services. Design changes and other

Courtesy of Muncie Gear Works, Inc.

Figure 14 — Exterior view of 5 H.P. Model AA-4 Neptune Motor.

adjustments surmounted the problem, however, so that these motors performed a valuable contribution. This problem in its more serious aspects was limited to the large horsepower motors where pre-ignition subjected the piston to excessive heat and pressure. Fig. 15 shows a typical illustration of piston failure caused by early ignition.

The best way to insure against spark plug deposits and fouling is to use a high quality outboard motor oil properly mixed in the correct proportions with a good quality gasoline.

OIL-TO-GASOLINE MIXTURE RATIO

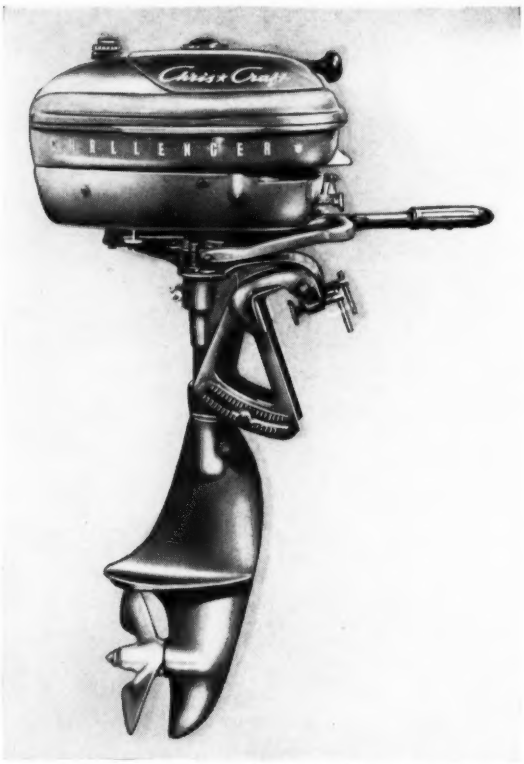
The manufacturers of outboard motors have worked out proper lubrication recommendations for each model and usually this information is printed on a plate attached to the engine. Wall charts and booklets showing the proper oil-to-gasoline mixture ratio for every make and model of outboard motor are published by most oil companies and are available in service stations.

Racing engines require a heavier oil than general service outboard motors. An SAE 50 or SAE 60 highly refined straight mineral oil is usually recommended when racing, using gasoline for fuel.

GREASE

The gears in the lower gear case are generally lubricated by a special type of grease. As noted above, an SAE 90 EP lubricant is used on one of the new shift models and certain other models use the same type of oil as is used in the fuel mixture. When grease is used it should be one compounded from specially selected soaps and special oils so that the final product has all of the desired properties. These would include proper body, low starting torques at low temperatures yet adequate body at high temperatures; proper adhesiveness, so that a film on the gears will protect them from rusting and corrosion; and proper oil films to insure perfect lubrication under all conditions. The grease seals of these motors are designed to prevent the entrance of water into the gear case, but although this problem has been largely overcome, some water will occasionally find its way into the housing.

Figure 15 — Although hole is shown in top of piston crown, failure may also occur in the ring area or occasionally in the piston skirt.



Courtesy Chris-Craft Corporation

Figure 16 — Exterior view of Chris-Craft 5.5 H.P. Outboard Motor.

Proper maintenance: i.e. removing the water and repacking the housing with fresh grease is a practice that should be carried out at regular intervals.

GASOLINE

In order to get top performance from service type outboard motors, it is not necessary or desirable to use premium grade gasoline. All outboard motors except racing engines are designed to operate satisfactorily on regular priced automotive type gasoline of 70 minimum ASTM octane number. The use of additives in the gasoline for the purpose of increasing speed or power is not recommended. Such additives actually may be harmful.

The fuels used in outboard racing motors are generally especially prepared by and for the driver, and the formulas are not widely publicized. Some racing fuels, however, have methanol as their chief ingredient and as mineral oils are not soluble in this fuel, castor oil is then used as the lubricant.

SALT WATER

Many outboards are operated in salt water so the care which should be observed in this service should be noted, i.e.:

Do not allow the motor to stand in the water when not in use. Whenever possible, the engine should be operated for a few moments in a barrel of fresh water or the cooling system flushed with fresh water to prevent corrosion and accumulation of salt deposits.

Wiping the motor with a slightly oily rag after such use also is beneficial.

The gear plugs in the case should be removed and any water entrained run out by rocking the motor; then repack with additional grease.

STORAGE

The proper storage of an outboard motor during the winter is important so that no difficulty is encountered the following Spring in quickly and easily preparing for the new season. Before laying the engine away the cooling system should be flushed with fresh water. This can be accomplished by running the motor for a short period (2 to 5 minutes) in fresh water or using a hose. The fuel should be drained and the fuel system (gas lines and carburetor) should be cleaned. New grease should be forced into the housing until all the old grease is forced out of the vent; then the motor should be turned over a few times so that this new grease is distributed over the gears to protect them until next season. Spark plugs should be removed and the points dipped into oil. A small amount (1 to 2 tablespoonsful) of oil should be poured into each cylinder and after replacing the plugs rotate the motor a few times by hand to distribute an oil film over the piston and cylinder walls as a protection against rust. Upon completion of these precautions the motor should be wiped with a dry and then with an oily cloth and wrapped in either canvas or heavy paper as protection against the atmosphere. The motor should be stored upright in a normal operating position in a dry place.

REMOVAL FROM STORAGE

Returning the motor to service the next spring is quickly accomplished by removing and cleaning the plugs, checking the gap, etc., spinning the motor a few times while the plugs are out to remove excess oil from the cylinders. Fill the fuel tank with a fresh blend of fuel, attach all wires, tighten all nuts and the motor is ready to take on the first trip.

CONCLUSION

Outboard motors and their close relations, the 2-cycle engine, powering generators, etc., have firmly established themselves in the American way of life. They have become a dependable source of power that finds many uses in both the work-a-day and recreational activities of everyone. Further refinements in design and mechanical features will no doubt be made in the future by this progressive industry, but the manufacturers have done an excellent job of taking the work out of play.

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TEXACO LUBRICATION CHART FOR OUTBOARD ENGINES

Use only Texaco Outboard Motor Oil in all outboard engines for which either SAE 30 or SAE 40 Oils are specified. These are listed in the following chart, together with the quantity of oil required per gallon of gasoline. Do not mix oil and gasoline in motor tank. Mix thoroughly in separate container. Texaco Outboard Motor Oil is a specially blended straight mineral oil for outboard engines. It falls within the SAE 40 classification. This oil is also extremely satisfactory for use in 2-cycle engines (where the lubricant is mixed with the fuel), power generators, lawn mowers, chain saws, etc. The "pints of oil per gallon" shown are for engines which are already broken in. A mixture using 50% more oil is recommended during break-in of new engines.

NAME AND MODEL	Pints of Oil Per Gallon Gasoline
CHAMPION	
A, 1B, 2B, 3B, S1C, D1C, S2C, D2C, D3C, R1C, S1D, D1D, S2D, D2D, D3D, S1E, D1E, D2D, D3D, S1F, D1F, S2F, D2F, B1F, S1G, D1G, S4G, D4G, 2G, 3G, M1G, M4G, M2G, 1H, 2H, 3H, 1J, 2J, 1K, 2K, 4K	¾
CORSAIR	
4820, 4821, 4823, 4921, 4927, 4923	½
ECLIPSE	
SM, SB, SMD	½
TMD	¾
EVINRUDE & ELTO	
Ace: 4145, 4205, 4256, 4301, 4329, 4351	⅓
Big Four: 802, 814, 8014	2
Big Twin: L, LA	½
Cub: 4264	⅓
Fastwin: R, RS	⅔
Fastwin: H145	1½
Fisherman: 4148, 4152, 413, 4016, 4093, 4227, 4267, 4269, 4309, 4312	½
Fleetwin: 418, 450, 4034, 4335 F, IF, 139	1 ⅔
Foldlight: 162, 403, 404	¾
Handifour: 4219	¾
Handitwin: 4158, 4212, 4261, 4307, 4332, 4357	⅓
Junior Quad: 900, 914, 924	1
Lightfour: 4042, 4111, 4178, 4231, 4271, 4315, 4383, 4389	¾
Light Twin: A, B, C, D	¼
Light Twin: G, H, J, K, 402, 407, 4097, 4153	½
Lightweight: 360, 444, 90000, 401, 411	½ ½
Lightwin: 442, 4020, 4221, 4289, 4313	½
Lightwin Imperial: 4030, 4102, 4165	⅔
Mate: 4263	⅓
Pal: 4203, 4253, 4266	⅓
Quad: 70000, 79999, 314, 700, 721, 732	1 1½
Ranger: 4252, 4265, 4406, 4407	⅓
Scout: 4201	⅓
Senior Speedster: 310, 312, 361, 363	¾
Service "A": 424, 425	1
Service Twin: J, K, 358, 359, 4161, 4216	⅓ ½
Single: A, 4000, 4008	½ ⅔
Special Speedster: 905, 907	1
Speedifour: 704, 715, 728, 7022, 7026, 7031	1½
Speediquad: 7000	1½
Speediquad Imperial: 7008, 7019	1½
Speeditwin: T	1¼
Speeditwin (Advanced): 6000, 6011, 6018, 6026, 6034, 6039	1½
EVINRUDE & ELTO (Continued)	
Speeditwin (Utility): U, 1U, 143, 156	2
Speedster: 300, 340, 348, 60000, 80000	¾
Sportfour: 902, 912, 920, 9000, 9022, 9026, 9031, 9035	1
Sportfour Imperial: 9008 to 9019	1
Sport Single: 432	⅔
Sportsman: 4091, 4146, 4207, 4254, 4296, 4346, 4364, 4412, 4416, 4425	½
Sportwin: 1N, N, 183, 4156, 4209, 4258, 4303, 4353, 4368, 4371, 4421, 4423	⅔ ½
Storm Boat Motor (See Outboard Engines—Racing Models)	
Sturditwin: 420, 421	1
Super "A": 422, 456	1
Super "C": 605, 624, 638	1½
Super Single: 436	⅔
Weedless Lightwin: 4341	1
Zephyr: 4359, 4363, 4378, 4381, 4402, 4404	½
FIRESTONE	
Standard Single: 10-A-1, 10-A-1A, 10-A-4	½
DeLuxe Single: 10-A-1, 10-A-2	½
Supreme Single: 10-A-2	½
DeLuxe Twin: 10-A-3	½
Supreme Twin: 10-A-3	½
FLAMBEAU 2.5, 5, 10	⅔
HIAWATHA 25-7956, 25-7971	½
JOHNSON	
Sea Horse, A, AA, AT, BN, DS, DT, F, HA, HD, HS, J, K, LT, MD, MS, OA, TD, TS, 100, 110, 200, 210, 300	½
K35, K40, K45, K50, K65, K70, OK55, OK60, P-30	¾
K75, K80, KA, KD, KS, O, P35, P45, P50, P65, P70, P75, P80, PA, PE, PO, S, SD, SE, TR, V	1
KIEKHAEFER	
Mercury, Mercury DeLuxe	¾
Wizard	¾
LAUSON Sport King, A-410	—
MARTIN	
20, 40	½
60	¾
MUNCIE (See Neptune)	
NEPTUNE	
A-1, B-1, A-2, AA-2, AA-4, AA-6	⅔
AA-10	1
POWER-PAK	
A-45, B-45, C-45	½
D-45, E-45	1
SCOTT-ATWATER 461, 467, 468, 469, 470, 471, 472, 473, 480-1-12, 481-1-12, 483-1-20, 491-1-14, 497-1-16, 493-1-20	½
SEA KING	
GG	½
EA8822A, 9002, 8812A, 8813A, 8814A, 8815A	½
8823A, 8824, 8824A, 9008, 8816A, 8817A	½
8811A	1
3818A, 8818A	1½
KI	¾
8806, 8763, 8764, 8765, 8766, 8809	½
9186, 8803, 8807, 8810, 9006, 9012, 9003, 9007, 9014	½
9194, 8390, 8800	⅔
9200, 8300	¾
8394, 8804, 8802, 8805, 8808, 8811	1
9188, 9190, 9198	1½
GG9017	1
TROLLAR Single	½
WEST BEND	
Water Witch	¾
Elgin 571: 58301, 58601, 58611, 58621	¾
571: 58401, 58501, 58511, 58521	½

OUTBOARD ENGINES (Racing Models)

Use only Texaco Aircraft Engine Oil 100 (SAE 50) or 120 (SAE 60) in outboard racing engines. These are listed below, together with the quantity of oil required per gallon of gasoline. Do not mix oil and gasoline in motor tank. Mix thoroughly in separate container.

EVINRUDE & ELTO	
Midget Racer: (Class M): 454, 4028, 4119, 4184, 4244, 4284, 4328	2
Speeditwin Racer: (Class C): 177, 609	2
Racing "460": (Class F): 178, 804, 826, 827, 828, 829, 8000, 8001, 8002, 8003, 8004, 8005, 8006	2
Storm Boat: 8008	1
JOHNSON	
Racing: KR	1½
Racing: PR, SR, VR, XR	2

NOTE: Manufacturer recommends SAE 50

OUTBOARD DRIVE (Heavy Duty up to 300 HP)

These outboard drives are powered by both gasoline and Diesel Engines and are designed for heavy duty commercial service. The engine lubrication follows that recommended by the engine manufacturer. The drive recommendations are shown below:

	Lowest Expected Temperature Over		
MURRAY & TREGURTHA	90°F.	+32°F.	+10°F.
Harbormasters, 041, 042, 06, 07, 08	30	30	30
Harbormaster 031	80*	80*	80*

* 80—Texaco Universal Gear Lubricant EP-80.

OUTBOARD MOTOR GEARS

Keep Gear Housing Filled with Texaco Outboard Gear Lubricant • Where Oil is Recommended use Texaco Outboard Motor Oil

NOTE: Johnson Model 130—Texaco Universal Gear Lubricant EP-80 recommended

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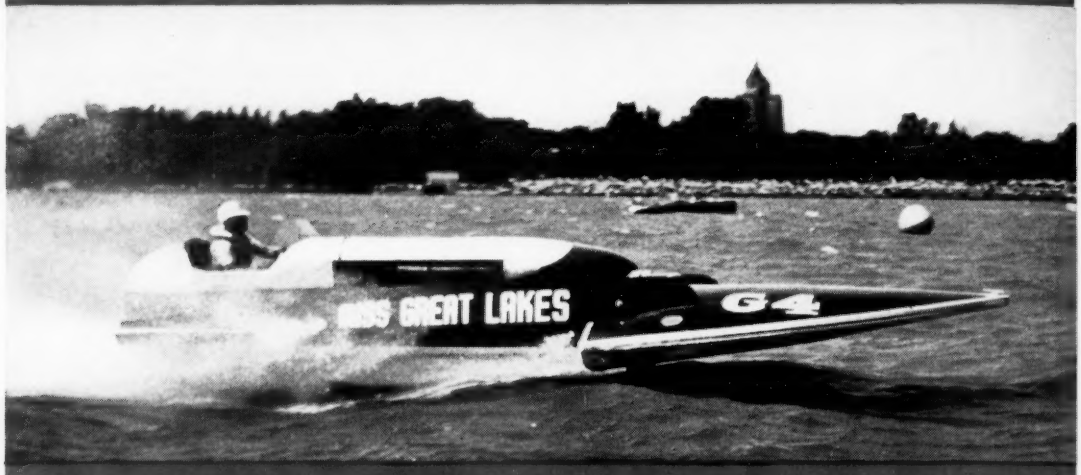

TEXACO THE CHOICE

when the going's toughest

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There's *Texaco Marine Motor Oil* to keep engines *clean* — free from troublesome carbon, gum and sludge. America's leading boat and engine builders use and recommend it to assure utmost dependability, extra protection against wear, lowest possible upkeep costs.

And *Texaco Marine White Gasoline* really *powers* a boat — assures lightning starts . . . fast, smooth warm-ups . . . instant, surging power at the touch of the throttle. And it's *premium quality* — does not form gum in copper tanks or fuel lines!

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